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**Status of Emerging Standards for
Removable Computer Storage Media
and Related Contributions of NIST**

by

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Abstract

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Standards for removable computer storage media are needed so that users may reliably interchange data both within and among various computer installations. Furthermore, media interchange standards support competition in industry and prevent sole-source lock-in. NIST participates in magnetic tape and optical disk standards development through Technical Committees X3B5, Digital Magnetic Tapes, X3B11, Optical Digital Data Disk, and the Joint Technical Commission on Data Permanence. NIST also participates in other relevant national and international standards committees for removable computer storage media.

Industry standards for digital magnetic tapes require the use of Standard Reference Materials (SRMs) developed and maintained by NIST. In addition, NIST has been studying care and handling procedures required for digital magnetic tapes.

NIST has developed a methodology for determining the life expectancy of optical disks. NIST is developing care and handling procedures for optical digital data disks and is involved in a program to investigate error reporting capabilities of optical disk drives.

This presentation reflects the status of emerging magnetic tape and optical disk standards, as well as NIST's contributions in support of these standards.

Keywords: computer storage media, interchange standards; magnetic tapes, media interchange standards; magnetic tapes, Standard Reference Materials; optical disks, life expectancy; optical disks, media interchange standards; optical disks, error rate; test methods standards.

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Scope of Talk

This overview is on the status of emerging interchange standards for computer peripheral storage technologies which utilize removable optical disks and magnetic tapes

Computer Storage Media Interchange Standards

Media - optical, magnetic, mechanical, etc.

Physical format - track location, data code, etc.

Logical format - volume labels, files structures, etc.

Test Methods Standards

Why do we need standard testing methods for media characteristics?

When media interchange standards are adopted, standard test methods for testing media characteristics are needed for conformance testing.

Data Permanence Standards

A general data permanence testing methodology does not exist

There are no standards regarding longevity that can assist managers in planning how long the information may be stored on removable computer storage media.

NIST Participation in Standards Committees for Removable Computer Storage Media

- * Technical Committee (TC) X3B11 - Optical Digital Data Disks
Member and Chair, Test Methods Project Group**
- * Joint Technical Commission on Data Permanence
Member and Technical Liaison with TC X3B11**
- * NIST/NASA Working Group (Test Methods and Specifications for
356 mm Ruggedized Rewritable Optical Disk Media)
Chair**
- * Technical Committee (TC) X3B5 - Digital Magnetic Tapes
Member and Supply Standard Reference Materials**
- * ISO/IEC JTC1/SC23 Optical Digital Data Disks**
- * ISO/IEC JTC1/SC11 Digital Magnetic Tapes**

Technical Committee X3B11 Optical Digital Data Disks

- * Media Interchange Standards
- * Test Methods Standards
- * Label and File Structure Standards (X3B11.1)
- * 46 principal members
- * Meetings every two months
- * Work coordinated with ISO/IEC JTC 1/SC23

Status of X3B11 Projects

- * 356 mm (14 inch) WORM

Letter ballot passed TC X3B11.

TC X3B11 resolving comments on first Committee Document 10885 (CD 10885).

Next step is DIS (Draft International Standard) status

Status of X3B11 Projects

* 300 mm (12 inch) WORM

Next generation standard.

There are two proposed incompatible formats:

CCS (Continuous composite servo).

ECMA/TC31/TG300/91/8 (first draft 300 mmm, CCS, 05/91).

SSF (Sampled servo). LMSI proposed the MASS format.

TC X3B11 working in ISO towards an ISO standard (the ISO document will be used as the ANSI standard).

Status of X3B11 Projects

* 130 mm (5 1/4 inch) WORM

3 draft standards approved by X3B11. One new project using MO media:

- | | |
|--|----------------------------------|
| - Continuous Composite Servo (CCS). | ISO/IEC 9171 - A
X3B11/90-125 |
| - Sampled Servo 4/15 Modulation (SSF). | ISO/IEC 9171 - B |
| - Sampled Servo High Capacity. | ANSI X3.191-1991 |
| - CCS format using MO media, (CCW). | New approved
project |

Status of X3B11 Projects

- * 130 mm (5 1/4 inch) Rewritable (MO media)**

One draft standard

- CCS format ISO/IEC 10089 - A
- The ANSI document will be X3B11/90-165
aligned with ISO/IEC 10089 - A

Status of X3B11 Projects

- * 86 mm (3 1/2 inch) Rewritable CCS**
 - CCS similar to 130 mm Rewritable
 - The document was aligned with ECMA/TC31/91/32.
 - The ISO document will be used as the ANSI standard (ISO CD 10090). Expected release of the ISO standard: June 1992.
- * 86 mm (3 1/2 inch) Rewritable DBF**
 - X3B11/91-050.

TC X3B11 Test Methods Projects

Size	Status
356 mm (14 inch) WORM	Approved as an ANSI Standard: X3.199-1991
300 mm (12 inch) WORM	Call for editors
130 mm (5 1/4 inch) WORM - CCS	Document in preparation.
130 mm (5 1/4 inch) WORM - SSF	Document in preparation.
130 mm (5 1/4 inch), MO, CCS	X3B11/91-032 will go for public review.
90 mm (3 1/2 inch), MO, CCS	A new project will be requested shortly.
90 mm (3 1/2 inch), MO, DBF	New project. A Base Working Document is expected by August.

Test Methods for Media Characteristics of 356 mm Optical Disk Cartridge - Write-Once

ANSI Standard: X3.199-1991

Imbalance
Apparent Axial Runout
Residual Focus Error
Drop Test
Dead Weight Strength
Double Pass Retardation
Signal Characteristics
Optical Disk Write Power
Read Power
Narrow-Band Signal-to-Noise Ratio
Cross-Talk
Radial Runout
Residual Tracking Error Signal

Proposed American National Standards

Test Methods for Media Characteristics of 90 mm and 130 mm Rewritable Optical Disk Data Storage Cartridges with Continuous Composite Servo (CCS)

Moment of Inertia
Imbalance
Axial Runout and Acceleration
Radial Runout and Acceleration
Drop Test
Refractive Index
Thickness
Baseline Reflectance and
Reflectance Uniformity
Resolution (only for 130 mm)
Signal Imbalance

Erase Characteristics
Write Characteristics
Read Characteristics
Figure of Merit
Narrow-Band Signal-to-Noise Ratio
Cross-Talk
Prerecorded Characteristics
PEP Cross Track Loss

Approved ISO/IEC Standards for Optical Digital Data Disks

- * ISO 9660 Volume and File Structure of CD-ROM
- * ISO/IEC 10149 120 mm (CD-ROM)
- * ISO/IEC 9171, Part A 130 mm WORM CCS
- * ISO/IEC 9171, Part B 130 mm WORM SS 4/15
- * ISO/IEC 10089, Part A 130 mm RWRT CCS
- * ISO/IEC 10089, Part B 130 mm RWRT SSF, 4/15 Modulation

Data Permanence Standards

Joint Technical Commission on Data Permanence IT9-5 (ANSI) and Subcommittee 84 (AES)

Task Groups

TG I	Definitions
TG II	Storage and Handling
TG III	Transfer
TG IV	Optical Systems and Media
TG V	Magnetic Systems and Media

TC X3B11 Technical Liaison : F. Podio

Joint Technical Commision on Data Permanence Task Group IV Optical Systems and Media

- * Standards, test methods, recommended practices and specifications pertaining to the life expectancy and retrieval of information recorded on optical systems.
- * Currently developing a standard for life expectancy of CD's.
- * Call for editors for similar documents for other types of optical media.
- * Next meeting: October 21 and 22, 1991 - Tucson, Arizona
- * Technical discussions on:
 - Quality parameters and prediction methods

NIST/NASA Working Group

Scope of Tasks

Development of a set of Test Methods and Specifications for 356 mm (14 inch) Ruggedized Rewritable Media (sponsored by NASA, Langley Research Center).

Participation

Government and Industry.

Status

NIST Special Publication SP500 - 191: "Test Methods for Optical Disk Media Characteristics (for 356 mm Ruggedized Magneto-optic Media".

NIST/NASA Working Group

Test Methods for Media Characteristics of 356 mm Ruggedized Rewritable Media

Operational Environment Test
Non-operational Environment Test
Storage Environment Test
Environmental Qualification
Mechanical and Physical Characteristics
Substrate Characteristics
Recording Layer Characteristics
Preformat Characteristics
Media Lifetime

Technical Committee X3B5 Digital Magnetic Tape

- * Media Interchange Standards
- * Label and File Structure Standards
- * About 50 principal members
- * Meetings every three months
- * Work coordinated with ISO/IEC JTC 1/SC11

Status of X3B5 Projects

12.65 mm (0.5 in) Wide Open Reel Magnetic Tape

Category	ANSI	ISO	ECMA
Logical Format (Label and File Structures)	X3.27-1987	1001:1986	13-1985
Media Standard (Unrecorded)	X3.40-1983	1864:1985 (CD 1864)	62-1985

Status of X3B5 Projects

12.65 mm (0.5 in) Wide Open Reel Magnetic Tape

Physical Format Standards

	ANSI	ISO	ECMA
200 cpi	X3.14-1983	1862:1975 (R 1986)	-
800 cpi	X3.22-1983	1963:1990	62-1985
1600 cpi	X3.39-1986	3788:1990	62-1985
3200 cpi	X3.157-1987	-	-
6250 cpi	X3.54-1986	5652:1984	62-1985

Status of X3B5 Projects

12.65 mm (0.5 in) Wide, 1491 CPMM (37871 cpi) Magnetic Tape Cartridge "3480 Technology"

Category	ANSI	ISO	ECMA
Logical Format (Label and File Structure)	X3.27-1987	1001:1986	13-1985
Media (Unrecorded)	X3.180-1990	9661:1988	120-1987

Status of X3B5 Projects

**12.65 mm (0.5 in) Wide, 1491 cpmm (37871 cpi),
Magnetic Tape Cartridge "3480/3490/3490E Technology"**

Physical Format Standards

	ANSI	ISO	ECMA
GCR, 18 tracks, 200 MBytes	X3.180-1990	9661:1988	120-1987
GCR, extended format, 18 tracks	X3B5/90-342 (3rd draft)	-	TC17/91/6 (2nd draft)
GCR, 36 tracks, parallel serpentine	-	-	-

Status of X3B5 Projects

**8 mm (0.315 in) Wide, Helical Scanned
Magnetic Tape Cartridge**

Category	ANSI	ISO	ECMA
Physical format	X3.202-199X (dpANS)	DIS 11319	145-1990
Media (unrecorded)	X3.202-199X (dpANS)	DIS 11319	145-1990

Status of X3B5 Projects

3.81 mm (0.150 in) Wide, Helical Scanned Magnetic Tape Cartridge

Physical Format Standards	ANSI	ISO	ECMA
DDS-DC Format	X3B5/90-323 (1st draft)	-	TC17/91/5
DDS Format	X3.203-199X (dpANS)	DIS 10777	139-1990
DATA DAT Format	X3.205-199X (dpANS)	DIS 11321	146-1990
Media Standard (Unrecorded)	X3.201-199X (dpANS)	DIS 11321	146-1990 TC17/91/5

Status of X3B5 Projects

19 mm (0.748 in) Wide, Helical Scanned Magnetic Tape Cartridge

Category	ANSI	ISO	ECMA
1st pdp, Unrecorded	X3B5/91-178 (1st draft)	-	-

Status of X3B5 Projects

New Projects

- | | | |
|---|---|----------|
| * | Media and physical standard for 12.65 mm (0.5 in) Helical Scanned Cartridge, 20 GBytes capacity, 3480 form factor | Approved |
| * | Media standard for D-2, 19 mm Helical Scanned Cartridge (Metal T-film) | - |
| * | Media standard for DD-2, 19 mm Helical Scanned Cartridge (Metal T-film) | - |
| * | Physical format standard for 12.65 mm (0.5 in), 36 track, parallel serpentine (400 MBytes capacity). "3490E technology" (CrO ₂) | - |

Approved ISO/IEC Standards for Magnetic Tapes

- | | | |
|---|--------------|--|
| * | ISO/IEC 1864 | 0.5 in Open Reel Magnetic Tape, (Unrecorded) |
| * | ISO/IEC 1862 | 0.5 in Open Reel Magnetic Tape, 200 cpi, (Physical Format) |
| * | ISO/IEC 1863 | 0.5 in Open Reel Magnetic Tape, 800 cpi, (Physical Format) |
| * | ISO/IEC 3788 | 0.5 in Open Reel Magnetic Tape, 1600 cpi (Physical Format) |

Approved ISO/IEC Standards for Magnetic Tapes

- * ISO/IEC 5652** 0.5 in Open Reel Magnetic Tape,
6250 cpi (Physical Format)
- * ISO/IEC 9661** 0.5 Magnetic Tape Cartridge,
"3480 Technology", (Unrecorded and
GRC, 18 Tracks, Physical Format)
- * ISO/IEC 1001** 0.5 Magnetic Tape Cartridge,
"3480 Technology",
(Label and File Structure)

Related Contributions of NIST

- * Active Participation in Standards Committees**
- * Optical Media Research Program**
- * Digital Magnetic Tape Program**

NIST Optical Media Research Program

Standards

Data Interchange (Participation in TC X3B11 and ISO/SC23)

Test Methods (Leadership in TC X3B11 Test Methods Project Group)

Data Permanence (Technical Liaison between JTC and TC X3B11)

NIST/NASA Working Group (Chair and technical editor)

NIST Optical Media Research Program

Research and Development

Methodology to determine the life expectancy of optical media.

Care and handling of optical media.

Test methods for media characteristics.

Program for investigating error reporting capabilities of optical disk drives.

Optical Disk Laboratory

- Optical disk drives
- Electronic Instrumentation
- Automatic measuring systems for media characteristics
- Optical inspection systems
- T/H chambers and ovens with computer control
- Access to scientific computers (modelling)

Aging Tests

Aging tests were run on 300 mm (12 inch) WORM media.

Over 5000 hours of testing

Three groups of disks:

- * 80°C, 90% RH
- * 70°C, 90% RH
- * 60°C, 90% RH

NIST Testing Methodology for Determining the Life Expectancy of Optical Disk Media

Some conclusions:

Life expectancy values strongly depend on several factors:

- * the test methods for the quality parameter(s)
- * the aging methodology
- * data patterns written
- * the areas measured
- * amount of data tested
- * statistical methodology (i.e. number of disks, number of samples, etc)
- * End-of-life definition

A complete specification of these conditions is essential in any comparison of life expectancy values

Program for Investigating Error Reporting Capabilities of Optical Disk Drives

- * Workshop held August 5th, 1991 in Colorado Springs, CO
- * Creation of an Government/industry Working Group
- * Demonstration platform

Optical Disk Drives Error Reporting Considerations

- * Most optical disk systems do not report sufficient information to the host on error rates, error distributions, etc.
- * Error rate information would include parameters such as the total number of correctable errors, maximum number of errors per interleave, and the location of these errors.
- * This information would provide data managers with a better understanding of the status of their data.
- * Monitoring the status of data recorded on optical media is particularly important because of its anticipated use for the long-term storage of valuable data.

NIST Government/Industry Working Group

- * Technical representatives from Government and industry.
- * Document standardized method(s) of reporting error rate information (NIST guideline/standard).
- * Contributions to relevant standards committees.
- * Meetings concurrently with TC X3B11 (Optical Digital Data Disks).
- * First meeting: October 7, 1991, Phoenix, AZ.
- * Target date for NIST publication: end of FY92.

Demonstration Platform

- * Demonstration of the state of the art in error rate monitoring and reporting techniques as well as the interface capabilities to U.S. Government managers.
- * Two hosts:
 - SUN SPARCstation IPC
 - Compaq 386/25e
- * Optical disk drives.
- * Adapt the demonstration platform to accommodate next generation drives with enhanced error reporting methodologies.

NIST Digital Magnetic Tape Programs

World source for digital magnetic tape Standard Reference Materials (SRMs)

Appraisal of potential risks associated with storing data on 12,65 mm (0.5 inch) CrO₂ "3480 technology"

- * Literature search
- * Consultation with users and manufacturers
- * Development of reasonable measures for the proper use of the 3480 tape cartridge

Federal agencies technical support for the care and handling of digital magnetic tapes

Standard Reference Materials for Digital Magnetic Tapes (SRMs)

- * SRM are materials that NIST produces that are calibrated against a generally accepted Master Standard
- * For magnetic tapes, some properties cannot be directly specified in standards (e.g., output signal amplitude is dependent on head used in drive)
- * Therefore reliable interchange of data requires that the tapes be designed and manufactured on the basis of a comparison to a known and accepted SRM. Currently, NIST is the world source for these SRMs.

Standard Reference Materials for Digital Magnetic Tapes (SRMs)

Parameters measured by NIST

- * Output signal amplitude
- * Typical current
- * Resolution
- * Overwrite
- * Peak shift

SRM Tapes Provided by NIST

SRM 1600	3.8 mm, 63 ftpmm cassette
SRM 3216	6.3 mm, 126 ftpmm cartridge
SRM 3217	6.3 mm, 126 ftpmm cartridge
SRM 3200	12.65 mm, 8/32/126 ftpmm open reel
SRM 6250	12.65 mm, 356 ftpmm open reel
SRM 3201	12.65 mm, 262/394 ftpmm cartridge
Proposed SRM 3202	12.65 mm, 972 ftpmm cartridge
Under development	6.3 mm, 394 ftpmm cartridge
Under development	6.3 mm, 492 ftpmm cartridge

